

## REMARKS

Claims 1-40 remain in the application. Independent Claims 1 and 21 are amended to emphasize distinctions over cited art.

Claims 1-3, 20-23, and 40 are rejected under 35 USC 102(b) as being anticipated by IBM Technical Disclosure NN8902444, Vol. 31, No. 9, pages 444-450 (hereinafter "IBM Disclosure")

The IBM Disclosure discloses a molecular electronic circuit device that functions as a flip-flop, an inverter, an OR logic gate, and as an AND logic gate.

Applicants' independent Claim 1 is directed to an electric field activated molecular switch comprising a molecular system that has an electric field induced non-redox type of band gap change resulting from an intramolecular change *in conjugation* as  $p, \pi$ -electrons of the molecular system, through its highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO), are alternately localized and delocalized over the entire molecular system by an applied electric field. The electric field induced band gap change occurs via one of the following mechanisms: (1) molecular conformation change or an isomerization; (2) change of extended conjugation via chemical bonding change to change the band gap; or (3) molecular folding or stretching. The non-redox type of band gap change results from an intramolecular conformational change in conjugation, and does not involve an oxidation-reduction reaction.

Dependent Claims 2, 3, and 20 depend from Claim 1.

Independent Claim 21 recites a method of electrically switching between two different states in the electric field activated molecular switch. The method comprises applying a voltage to a pair of wires to cause a change in the state of the molecular system at the junction thereof.

Dependent Claims 22, 23, 40 depend from Claim 21.

The Examiner argues that the IBM Disclosure discloses a molecular switch that is activated by an applied molecular field. This is true. However, the Examiner then argues that the band gap change in the molecule takes place by the mechanism of a conformation change which is a twisting, with the rotor portion being the portion that carries out the twisting motion.

However, there is no evidence that the molecule shown in Figures 1 and 2 of this reference twists. Rather, it is in a fixed configuration, with one ring of the molecule in the plane of the paper and the other ring 90 degrees out of the plane of the paper, with the two rings connected by a spiro carbon. As plainly described at the top of page 2, **tunneling** is the mechanism for switching:

"If the molecule were to be placed between two electrodes, so that the axis, which is normal to the electrodes, passes through the spiro carbon and is a [sic: at] ninety degrees to both pi-systems, then under the influence of a field, electrons may tunnel from one electrode to the conductive pi-group. This will occur if that group is (+) charged, and from the other pi-group to the other electrode, as shown in Fig. 3. This simultaneous electron transfer renders the conductive chain insulating and the insulating chain conductive. In other words, the molecule shown is a molecular flip-flop."

Further, the aliphatic chain and bi-ring bridge structures described and shown in the IBM Disclosure do not contain pi electrons and are, therefore, **incapable** of extending pi-electron conjugation across the switching molecule, independent of any conformational change their molecule may undergo in the switching process. That is, the switching mechanism described in the IBM Disclosure occurs through an entirely different mechanism (e.g., tunneling) than that provided in the present invention as claimed.

Applicants can find no disclosure anywhere in this reference of an electric field activated molecular switch comprising a molecular system that has an electric field induced non-redox type of band gap change resulting from an intramolecular change in conjugation as p, $\pi$ -electrons of the molecular system, through its highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO), are alternately localized and delocalized over the entire molecular system by an applied electric field, wherein said electric field induced band gap change occurs as a conformational change via one of the following mechanisms: (1) molecular conformation change or an isomerization; (2) change of extended conjugation via chemical bonding change to change the band gap; or (3) molecular folding or stretching. Applicants would appreciate it if the Examiner would specifically point to the locations in

the IBM Disclosure that purportedly anticipate Applicants' claimed invention, keeping in mind that there are a variety of molecular switches that function on totally different mechanisms that do not disclose or teach Applicants' claimed invention.

Thus, the IBM Disclosure does not teach or suggest the claimed electric field activated switch. "A claim is anticipated [under 35 U.S.C. § 102] only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdęgaal Bros. v. Union Oil Co. of California*, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987). See M.P.E.P. § 2131. For at least these reasons, the rejection based on the IBM Disclosure of Claims 1 and 21, and their respective dependent claims, should be reconsidered and withdrawn.

Inasmuch as the molecule disclosed in the IBM Disclosure is the same one as disclosed in the Hush et al reference, the comments below further distinguish Applicants' claimed invention over the cited art.

Reconsideration of the rejection of Claims 1-3, 20-23, and 40, as amended, under 35 USC 102(b) as being anticipated by the IBM Disclosure is respectfully requested.

Claims 1-3 are rejected under 35 USC 102(b) as being anticipated by Hush et al (JACS 1990 Vol. 112, pp. 4192-4197).

Hush et al disclose electron and energy transfer through bridged systems.

The rejected claims are discussed above.

The Examiner argues that Hush et al disclose field activated intramolecular configurational change in molecules and that the molecules are molecular switches that can be used in logic circuits and thus in memory devices.

At the outset, it should be clear that the configuration of a molecule is the **permanent** geometry that results from the spatial arrangement of its bonds. The ability of the same set of atoms to form two or more molecules with different configurations is stereoisomerism. The term "configuration" is distinct from the term "conformation", which is a shape attainable by bond rotations. Clearly, a change in configuration hardly discloses or even remotely suggests a change in conformation.

For the "intramolecular **configuration** change" mentioned by Hush et al (page 4192, first column, second paragraph), it really means that molecular configuration changes from an original "D-B-A" to "A-B-D" via electron or hole transfer under the

influence of external perturbation (see Col 1 at pp 4192), where “D” = donor moiety, “A” = acceptor moiety, and “B” = bridging moiety. In their model for this type of molecule, the “B” in their molecular structures represents either a linear saturated hydrocarbon chain with at least 3 sigma-bonded saturated hydrocarbons or two or more saturated cyclic hydrocarbon rings linked by one or more spiro-carbon centers via sigma-bonds (see Figures 1, 2 and 3, at pp. 4193). During their intramolecular change, only the electronic configuration of “A” and “D” is switched via electron or hole transfer. **“B” remains unchanged.** As noted above for this molecule, the aliphatic chain and bi-ring bridge structures described and shown in the Hush et al do not contain pi electrons and are, therefore, **incapable** of extending pi-electron conjugation across the switching molecule.

Applicants’ claimed switchable molecules belong to “Conj<sub>1</sub>-B-Conj<sub>2</sub>” type of structure. The “Conj<sub>1</sub>” and “Conj<sub>2</sub>” represent two conjugated molecular fragments and the “B” here is either a single bond or an unsaturated hydrocarbon chain to link both conjugated molecular fragments together. Applicants change the molecular electronic and optical properties by changing “B”. The ways used to change “B” or to change the extended conjugation of the molecule are by (1) changing the molecular **conformation** via bond rotation or molecular folding or stretching; (2) an isomerization; or (3) chemical bonding change from sigma-bond to pi-bond to change the band gap. In one switch state, Applicants’ molecules are fully conjugated (pi electrons are delocalized over the entire molecule), while in another switch state, that conjugation is altered (pi electrons are localized to regions of the molecule); see, e.g., paragraphs 0081 and 0083. No such change takes place in the molecule disclosed by Hush et al. Indeed, it would be clear to one skilled in this art that the molecule of Hush et al is incapable of such localization-delocalization of pi-electrons upon application of a switchable external field.

There is distinct difference between Hush et al’s disclosure and Applicants’ claims, which derives solely from whether the “B” is changed or not. Hush et al change configuration (or orientation of molecular polarization) of the molecule via intramolecular electron or hole transfer without changing their “B”, whereas Applicants change the extended molecular conjugation by changing the “B”.

In the context of rotation, for example, the molecule of Hush et al is **incapable** of rotating such that all parts of the molecule are co-planar (pi electrons delocalized). The presence of the spiro carbon forces one ring into one plane and the other ring into a perpendicular plane, thus localizing the pi electrons to their respective rings (see, e.g., Fig. 1 of the IBM Disclosure). Application of an electric field cannot cause the two rings to become coplanar (and thus delocalize the pi electrons), as is true for Applicants' claimed molecules.

More importantly, and independent of a conformation change, the disclosed molecule, common to both the IBM Disclosure and Hush et al, contains bridging units (B) that do not contain pi-electrons and, therefore, are incapable of changing the localization or delocalization of pi-electrons across the bridge and, therefore, the entire molecule.

Thus, Hush et al do not teach or suggest the claimed electric field activated switch. "A claim is anticipated [under 35 U.S.C. § 102] only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987). See M.P.E.P. § 2131. For at least these reasons, the rejection based on Hush et al of Claim 1 and dependent Claims 2-3 should be reconsidered and withdrawn.

Reconsideration of the rejection of Claims 1-3, as amended, under 35 USC 102(b) as being anticipated by Hush et al is respectfully requested.

The Examiner indicates that Claims 4-19 and 24-39 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Applicants appreciate this indication of allowability. In this connection, it is noted that independent Claim 21 already includes the limitations of Claim 38, and thus should be allowable over the IBM Disclosure.

The foregoing amendments and arguments are submitted to place the application in condition for allowance. The Examiner is respectfully requested to take such action. If the Examiner has any questions, the Examiner is invited to contact the undersigned at the below-listed telephone number. HOWEVER, ALL WRITTEN COMMUNICATIONS SHOULD CONTINUE TO BE DIRECTED TO: IP ADMINISTRATION,

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Respectfully submitted,

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